

Modelling crop-livestock integration systems on a regional scale in Reunion Island: sugar cane and dairy cow activities

Randrianasolo J., Lecomte P., Salgado P., Lepelley D.

Introduction

The sustainable rural development is one of the Reunion Island priorities, where a large part of the economy is based on the agriculture. One of the viable options would be to create an auto sufficient system where dairy cows' manure will be used as organic fertilizer to sugar cane fields and sugar cane by-products would be used as a supplement feed for dairy cows. These alternatives respond to insularity constraints, volatility of input prices, and policies to preserve environment. The efficiency and the effectiveness of these technical choices could be greatly improved if their ex-ante analysis is achieved. The key challenges for enhancing the usefulness of search tools for multi-criteria assessment is defined by their ability to change the level scale from micro to macro analysis, their ability to have a multidisciplinary analysis, and their generic flexibility to cope with a wide range of issues. This paper presents the justification, the components and the illustration of the modelling approach to represent the farming systems in Reunion Island, in order to assess the impacts of technical alternatives on cattle feed and crop fertilisation. We opted for a framework allowing the data linkage to each model components. This offers flexibility of the model and data coupling. A multidisciplinary approach was used, based on a dynamic linear programming model that integrates technical, socio-economic and environmental constraints.

Model description

The model components have been developed with the General Algebraic Modelling System (GAMS) using an Interactive Multiple Goal Linear Programme approach, based on the standard linear programming structures as given by Nidumolu (2008). The model focuses on the nutritional balance for dairy cows based on their nutritive requirements (energy and protein; Hassoun et al, 2000) and capacity intake (UEL; Salgado et al, 2008). It takes into account the genetic milk potential and the physiological characteristics of dairy cows. A ratio between fodder and concentrate feed intake was established in order to limit the proportion of the both feeds. The nutritive value of fodder and concentrate feed results from laboratory analysis and Near Infrared Spectroscopy (NIRS) predictions. By-products from sugar cane activity (bagasse and straw) are used as alternative feeds by dairy cattle. The NPK balance for sugar cane and fodder fertilisation take into account the use of livestock manure. The model algorithm selected the crop types and areas to be used for covering the nutrient requirements of animals. The objectives of the models are to maximise the total revenue and to minimise operational costs.

Scenarios

The use of sugar cane by-products as supplement feed and the use of manure as fertilizer for sugar cane activity increase (about 2%) the gross margin of both activities. This increase is due to lower costs of concentrate feed (about 17%) and mineral fertilizer (about 50%) and an increase of dairy herd. The gross margin value is highly dependent with the transportation cost used (around 5€/ton/km). The negative impact of a decrease in milk production subsidies in the global profit is attenuated if crop and livestock activities are integrated at a regional level.

Conclusions

The model results confirm that the modeling approach is a reliable decision tool to assess the impact and eventual consequences of exogenous changes in agricultural systems.

References

- Nidumolu U., 2008. Report of the project 'MODLAIT'. 97pp.
- Hassoun et al, 2000. L'élevage bovin à La Réunion . CIRAD. 225–248.
- Salgado et al, 2008. Dairy Vietnam Farm Model (DAIVIE). CIRAD, 82pp.